Weatherwise

Volume 11, Number 6 December 1958

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE"—BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

DAVID M. LUDLUM, *Editor* HENRY W. BULKLEY, *Associate Editor*

A New Home for the AMS

THE acquisition of a new home for the headquarters of the American Meteorological Society on Beacon Hill in Boston was recently announced. A photograph of the site features our front cover. The historically famous mansion, known as the Bulfinch House, at 45 Beacon Street, overlooking Boston Common and only a short distance west of the State House, has been made available to the Society through the generosity of Miss Eleanora R. Sears, noted pioneer aviatrix and Boston philanthropist.

Built in 1806 by the celebrated architect Charles Bulfinch for Harrison Gray Otis, one of Boston's leading citizens in the Federal period, the property has been an outstanding feature of the Beacon Hill landscape for a century and a half. Miss Sears acquired the property in 1953 and formed the Bulfinch Trust to preserve the historic site. Now the Trust has turned the ownership of the property over to the AMS to use in its non-profit, educational activities. The Society for Preservation of New England Antiquities will counsel the AMS in maintaining the building.

The main building contains many sizeable rooms as well as adequate storage space. A large stable and a parking lot are located at the rear. Plans are now being formulated by the Executive Committee of the AMS to utilize the building for the administrative and editorial offices of the Society so that it may carry on its world-wide meteorological activities from an adequate base. The building will be open to the public to serve as an educational center in meteorology and for the inspection of all interested in this historic American landmark.

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Front Cover: The site of the new AMS headquarters at 45 Beacon Street, Boston, Massachusetts. Photo by George M. Cushing, Jr.

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A view of North Pearl Street, Albany, at the conclusion of the Blizzard of '88. The "path" in the center resulted from vain efforts to keep the horsecar tracks open.

The Blizzard of '88

(As it might well have been seen through the eyes of Sergeant J. O. Barnes, Meteorological Office, Signal Service, U. S. Army, Albany, New York.)

R. A. WRIGHTSON, *U. S. Weather Bureau, Albany, N. Y.*

BARNES, you think to yourself, you're a peculiar soldier. You neither tote a gun nor rattle a saber. For one thing, the nation is at peace; the nearest thing to warfare is the battle President Cleveland is overseeing between the free traders and those who would have high tariffs. But more than that, you're a new breed of soldier—a specialist, a technician of sorts. You, Sergeant Barnes, are in charge of the Albany, New York, meteorological office of the Signal Service, U. S. Army. The year is 1888—the month March.

There's an uneasy stillness in the air this Saturday, the 10th of March. It's a feeling you can't describe; something you can't put your finger on. Perhaps it's a feeling the Spanish sailors might have had before the great storm that sank much of their mighty armada sent by Philip II against England in 1588. Perhaps the English and French sailors in the Crimean War felt it in the air before the storm broke that sent their allied supply fleet to the bottom of the Black Sea in 1854. Yet it may be nothing more than a case of imagination playing tricks on you; so pick up the daily *Albany Argus* and forget all about the weather for a few minutes.

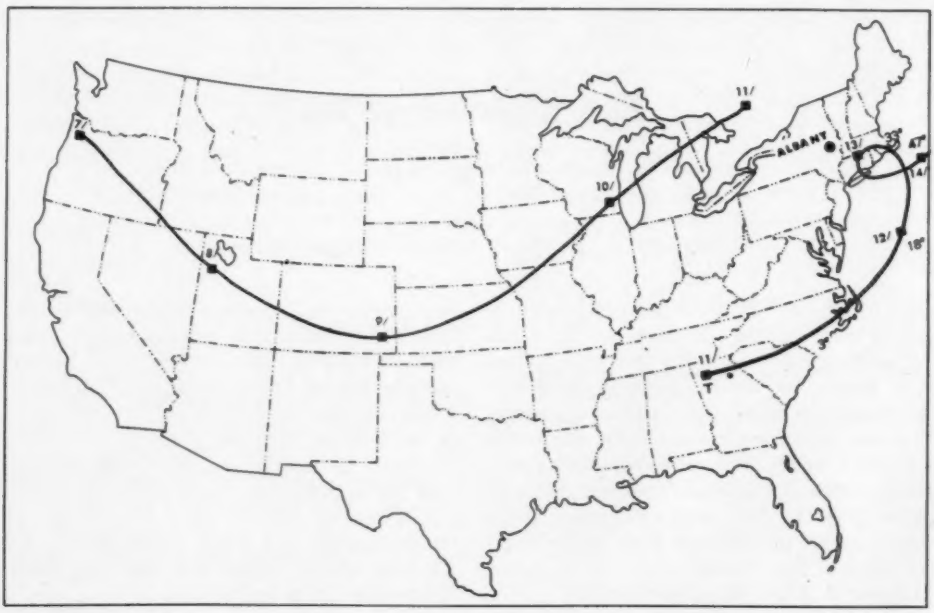
Governor Hill, you read, has a battle on Capitol Hill over appropriations for canals. In the sports section you see where John L.

Sullivan and Mitchell fought a bloody 39 round draw in England (John L is not the terror he used to be). In the entertainment section the item about the Leland Opera House catches your eye, for you plan to go there tonight. The Irish Minstrel is featured, and on a Saturday night you can be sure of a full and lively house. So hum the minstrel song "My Nellie's Blue Eyes," and contemplate the evening that lies ahead. Yet, try as you may, you can't forget the present weather situation and you are not at all happy about it. So recap the weather developments before taking the usual 3 P.M. observation. A storm that came in from the Pacific four days ago moved down across Salt Lake City on Thursday, eastern Colorado on Friday, and is now near Chicago. It's headed northeastward at a good clip and should be harmless enough. But, from the storm center near Chicago, a zone of low pressure extends southward to the Gulf coast. There are some signs that another storm center might be developing in the South. This, perhaps, is the crux of what is bothering you, for high pressure with cold air covers the Northeast. Situations like this often lead to heavy snow.

It is now exactly 3 P.M.; so check the barometer. The reading is lower than this morning—much lower. Next, go out on the roof of the Federal Building and get the temperature—42°. High, thin cirrus clouds overspread the sky and sunlight filtering through those clouds has formed a very prominent solar halo. Old timers believe this to be a sure sign of snow; and this time you suspect, the sages might well be right. Little by little, parts of a weather mystery may be falling into place. Barnes, you say to yourself, this has the earmarks of trouble. Telegraph your observation to Washington and go home.

Sunday—March 11

The minstrel was fine—the music great! But Saturday's fears seem well founded this morning. Those cirrus clouds of yesterday are hidden by lower clouds of the alto stratus variety. A brief flurry of snow dropped from those clouds around 10:28 A.M. and after 2:56 P.M. a very light snow fell steadily—folks hardly gave it a second thought. But it is now known that a definite storm center formed in the South near Augusta, Georgia, early today. Teeming rains in the Southland



The tracks of the parent low from 7 to 11 March and of the secondary from 11 to 14 March. Snowfall figures along the track of the secondary indicate the depth of snow on the ground at that time at Albany.

can do little else than turn into copious falls of snow when the storm swings northward. When night falls and you are going to church, the snow is getting heavier and there is some accumulation. During the sermon your thoughts stray as the wind whines around the steeple. When you reach the street, you are not too much surprised to see that snow has reached a depth of about two inches. At midnight measure the snow in several places to get a representative value, and in your weather log note that 2.8 inches of snow fell at Albany on March 11th.

Monday—March 12th

What a morning! Coming to work through 18 inches of snow was no easy matter. Horsecars are moving but are way off schedule. Snow is falling at the astounding rate of about an inch an hour. It is a light, feathery snow —a snow easily arranged into deep, troublesome drifts by a strong gusty wind. By noon, around 28 inches covers the ground. Mayor Thacher and Street Commissioner Russ wonder when would it end, but you can offer no hope of an early ending—the storm center still being too far away. A tidy fortune can be made today if one can beg or borrow a shovel, but no use trying to buy one for stores are long since sold out. Railroad and horsecar companies will hire anyone willing to work on the shovel gangs. But despite their efforts, snow seems to be getting the upper hand. Great delays are being reported by the railroads; and by afternoon rail traffic is near a standstill. In town, the horsecar company battles on through the long and weary day. Instead of the usual one or two horses on each car, they hitch up as many as six. By nightfall, snow has drifted to depths of 3 to 4 feet. It blows back over the tracks almost as soon as it is shoveled. In desperation, eight horses are assigned to each car. The cars surge forward but are derailed or get bogged down one way or other. . The storm has won another round. Exhausted horses are led back to the barns this awesome Monday night, and are undoubtedly in for a winter's vacation. The cars are left in the middle of the streets—their doors ajar. For many the cars become havens from the storm. After 10 P.M. it is dangerous to even venture out of doors. Defeated and weary, the town settles down for the night while the restless storm rages on. Falling temperatures compound the misery wrought by wind and snow. At midnight the temperature is down to 4.5°. The storm center is just east of Norfolk, Virginia, and is moving north-northeastward. Barnes, you say, this has been one rough day. Oh, to have a nice soft job like the Cavalry or Engineers. The snow you have just measured averages 33.2 inches, and so mark down today's contribution—30.4 inches, amazing! It's after midnight but there is little point of going home now. It's doubtful if you could make it if you tried. Anyway, a storm like this might come along only once in a century so you decide to stay with it to the bitter end. All is quiet in town except for a howling wind —a cat nap will help.

Tuesday—March 13th

This morning finds the storm center east of Atlantic City, New Jersey, and snow is still falling but not so steadily as before. Our spirits rise between 9 and 10 A.M. when the sun breaks through the overcast for a few precious moments. But by noon, snow is falling heavily and does so until around 3 P.M. when it slackens off a bit. Again today, nothing much moves down on the street; the one or two teams that do are being driven on the sidewalks. We learned today that the southbound train for Oneonta stalled in nearby Delmar, and that another train is snowed in near Canaan. Fortunately, near-starving passengers have found shelter with isolated farm families. Railway travel is still suspended and the depot is a virtual dormitory for stranded passengers. With some difficulty telegraph communications were worked with New York City, but contact with Boston and the East failed last night. The storm center is over eastern Long Island and appears to be slowing down, and perhaps even turning to the west. It seems headed toward Providence —a peculiar direction to take; but then nothing about the storm has been ordinary up until now. You recall vividly that high pressure was quite strong to the north. The storm has probably been halted by that high in its northward journey and we will likely see it head off in some other direction—most likely to the east.

Barnes, ole fella, it's that time again—it's midnight. Time to measure the snow once more. Boots, overcoat, ear muffs are the

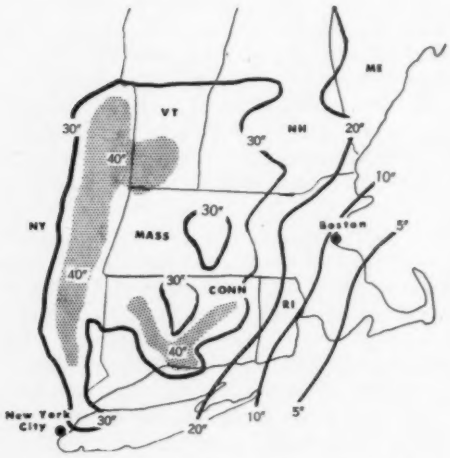
necessary gear for struggling through chest-deep snow. The average depth is now 45 inches—12 of that was today's fall. Was there ever such a storm before, you wonder? Anyway, according to newspaper accounts, it must have been before 1804. Again tonight you will be a prisoner in your own office on the fourth floor of the Federal Building, but you are too tired to care. Soldiers have not always had it this good; so rest your weary head on the desk and get a little shut eye. Tomorrow is another day.

Wednesday—March 14th

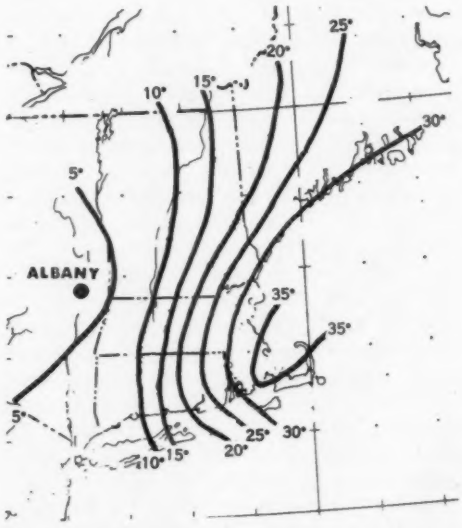
This morning's weather chart confirms the suspicion that the storm was actually going into a northwest turn last night. It seems to have made a tight loop and at 7 A.M. is near Hartford. It is headed southward at a rate that will place it over eastern Long Island by dark today. In Albany there is good news for all; the snow ended at 2:30 A.M., almost 60 hours after it began on Sunday. The final snow total was 46.7 inches. Drifts averaging 10 to 15 feet are common and some drifts are 20 feet deep. Not everybody is shoveling out from the storm; some people, especially in row houses, are tunnelling through it. Not everybody has been humbled by the big storm —man's innate good humor has risen to the crises and saved the day. On some of the higher drifts you will see such signs as "Keep off the grass" or "Perishable property." The Albany Snow Shoe Club brought us chuckles as they tramped up State St.; and this time at least, they had the undisputed right-of-way. The German Band really warmed our hearts as their bright uniforms and lively music struck back at the storm. But some young hoodlums near Madison and Green decided that the band was fair game and started to snowball it good and proper. The Band beat a hasty retreat into the nearest saloon, but the poor tuba player had some difficulty getting his instrument through the door and before he succeeded, a young rascal dropped a snowball the size of a grapefruit into the horn.

On the more somber side, the storm has brought untold suffering. Since city and post roads are impassable milk deliveries are not being made. There is a milk famine and it is especially serious for parents with very young children. Serious too, for dairymen. Undelivered milk must be dumped—that source of winter income, sorely missed. Neither coal

(*Continued on page 211*)



A chart of estimated total snowfall on 11–14 March in New England and the Hudson Valley of New York. Troy, New York, reported highest total of 55". New York City had 22" and Boston 12". Data from *American Meteorological Journal*, May 1888.



A chart of isotherms over New England at 2200 on 12 March 1888 at height of snowfall. A moist easterly flow was forced to rise over an intensely cold surface dome, resulting in excessive precipitation.

Climatic Trends in New Mexico

G. F. Von Eschen, *State Climatologist, Albuquerque, New Mexico*

WAS it as warm and as dry in New Mexico 50 years ago? or 25 years ago? How does our present-day drought compare with the drought of the mid-30's? Were not winters much colder during the early part of the century? These are some of the questions that arise in almost every discussion of climate and weather.

Whether or not our climate is changing, and if so—how great and how rapid has this change been?—is not only a question of interest to the man on the street, but is also of importance to agriculture and industry. Such information may form a basis for the evaluation of the causes of changing production and markets, and may also be used as a key to future planning. The matter of small or gradual climatic changes or trends, or at least the amount of such changes if they are present, is not easily established.

Unfortunately many factors other than climatic changes may affect our weather records. Temperature readings in urban areas may, over a period of half a century, be influenced by gradually changing environment. Cities spread out over ever increasing areas. Miles of streets are paved. Homes, with lawns and trees, spring up in the desert. Large industrial plants are built. While these signs of progress may not materially affect the temperature records of the nearby weather station, yet they invariably raise the question: are not the long period changes wholly obscured, entirely reversed, or considerably magnified by this changing environment?

Another problem affecting our city weather records is that stations have been moved, some many times, during the past 50 years. Exposures have gone from rooftops of downtown buildings to ground exposures in parks and possibly back to the top of another skyscraper, before moving to an airport several miles from the original location. Each move further complicates the record in its use to establish climatic trends.

Even our rural stations may be subject to some environmental change. The development of widespread irrigated areas with lush green fields where once only cactus and sage brush bloomed, the planting of trees around a farm home, the establishment of lawns, and the construction of new buildings; all these things change the environment of the weather station. Even more important, as a disturbing factor in the long term weather study, is the frequent relocation of the equipment as one observer can no longer serve and a new cooperator must be found. Such relocation may not materially change the exposure of the instruments, but each move makes the resulting temperature record less desirable for a study of long-period trends. Rare indeed is the weather station where the record has been relatively accurate and continuous and the instruments have not been moved or subjected to a changing environment for a period of 50 years.

In the investigation of long-period climatic changes the use of state or climatological division averages are not entirely satisfactory. The method of computing state or division means has changed from time to time, and even less desirable is the ever changing number and location of the stations whose records have gone into these areal averages. This study, therefore, was based on individual station records. An effort was made to select the most reliable and representative record available. The Bell Ranch climatological substation in eastern San Miguel County has a more nearly ideal record for such a study than any other station in New Mexico. This station was established at the ranch headquarters on 10 May 1899 with temperature records beginning on 14 October 1904. As far as can be determined from our files, the instrument shelter has not been moved since the day it was set up. The station is located in a large area of rolling grass land which has been used for grazing livestock throughout the years. With no important new buildings or changes in the ranch home, the environment of the weather station has been practically the same for half of a century.

CHART I

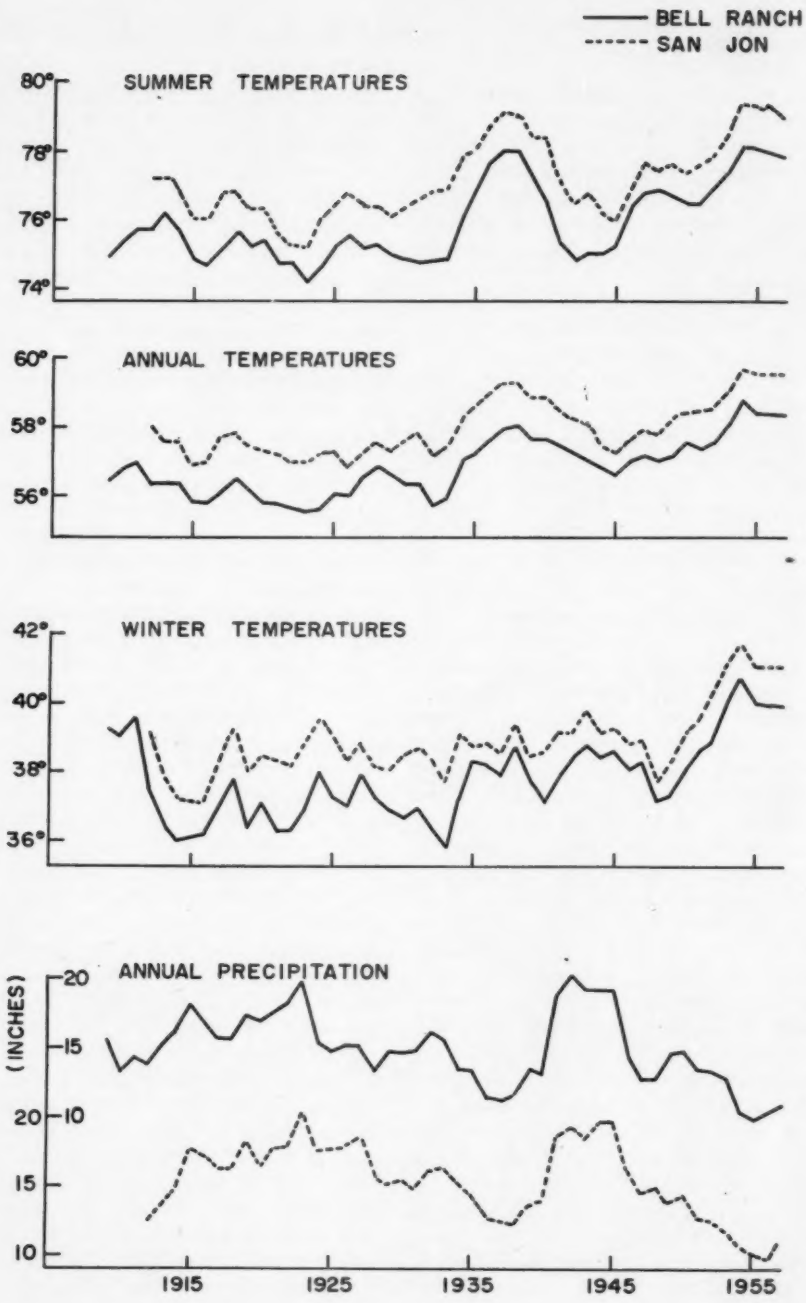
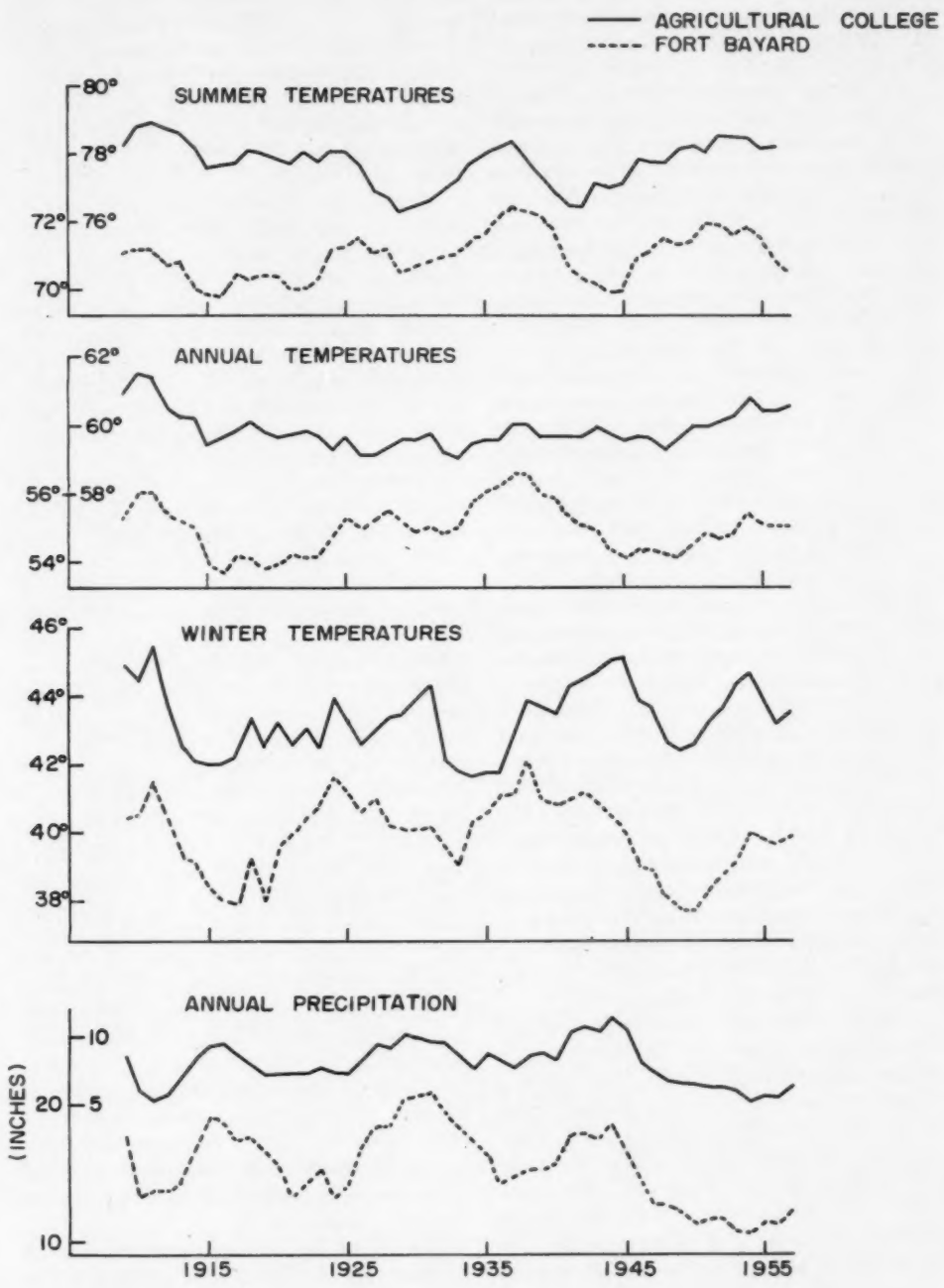

BELL RANCH
SAN JON
SUMMER TEMPERATURES
80°
78°
76°
74°
ANNUAL TEMPERATURES
60°
58°
56°
WINTER TEMPERATURES
42°
40°
38°
36°
ANNUAL PRECIPITATION
(INCHES)
20
15
10
20
15
10
1915
1925
1935
1945
1955

CHART II


AGRICULTURAL COLLEGE
FORT BAYARD
SUMMER TEMPERATURES
80°
78°
72°
76°
70°
ANNUAL TEMPERATURES
62°
60°
56°
58°
54°
WINTER TEMPERATURES
46°
44°
42°
40°
38°
ANNUAL PRECIPITATION
(INCHES)
10
20
5
10
1915
1925
1935
1945
1955

Continuity and quality of weather records have been very good. In fact there were only three months of missing temperature records during the entire period of over 50 years. (These missing temperatures were estimated in accordance with standard procedures to complete the record.)

To smooth somewhat the usual year to year variations and so point up long-range trends or changes more clearly, five-year progressive averages for annual mean temperatures, winter mean temperatures using the months December to February inclusive, and summer mean temperatures using the months of June to August inclusive, were worked. Five-year progressive averages of total annual precipitation were also computed. While rainfall, especially in New Mexico, may vary considerably between stations in the same area, it was thought that a representative trend would be obtained from a smoothed annual average at one station. These variously computed values are plotted in Chart I. The value plotted for each year is the average of the five-year period ending in that year.

As a check on the reliability of a one-station record analysis as an indication of the climatic changes in an area, another station in the same section of the State was selected and corresponding values computed. The San Jon station record was used as the next most suitable record for the purpose. This station was located at the White Ranch home on 1 February 1909 and has been continued with a minimum of missing record and little change in environment up to the present time. The values for San Jon are plotted on the same chart and in the same manner as are the Bell Ranch records. The very close conformity of the two curves would indicate that by selecting a representative record a one-station analysis is a good indication of weather changes in a climatologically homogenous area.

Several interesting features are evident from the plotted records. The annual mean temperature, although showing considerable variation, indicates a gradual upward trend in the curve since the early 20's. In other words, it has been getting warmer in northeastern New Mexico for the past 30 years or more. The so-called "dust bowl" days of the mid-30's are associated with a moderately warm period, but that earlier period was not as warm as the last few years have been. It is interesting to note that during the warm weather of the mid-30's, summer temperatures showed a marked rise while winters were not appreciably warmer than in earlier periods. However, during the warm weather of recent years, winter temperatures have shown a very marked warming while summers, although also showing a rising temperature trend, have not been significantly warmer than they were in the 30's.

Although the abnormally wet years of 1941 and 1942 materially effected the rainfall curve, the general trend of precipitation has been downward since the early 20's; in other words during the period when temperatures show an upward trend the precipitation curve slopes generally downward. It may be noted in the general variations that wet-cool periods and warm-dry periods are closely associated. This pattern of association is even more evident when the rainfall curve is compared with the summer temperature curve. This is probably due to the fact that normally by far the greater portion of New Mexico's rainfall occurs during the summer months.

As a check to see if these trends held true for other sections of New Mexico, the same data were computed for Ft. Bayard and Agricultural College. These stations are located in the south western part of the State. From the standpoint of continuity and stability of location without change in environmental influences, the Ft. Bayard record was selected as the key indicator in this area. The weather station has been located on the grounds of the Ft. Bayard Veterans Hospital for many years. This was a Public Health hospital in earlier years and before that was active as an Army Post. Located in a relatively high mountain valley, the surrounding country is rolling grass land covered with a very scattered stand of scrub pine. Except for some building and landscaping at the hospital, there has been no important environmental change. However, the equipment has been exposed at several different sites on the grounds during the many years of record. The weather records began in January 1887 and have been of generally good quality and fairly continuous since that time.

The Agricultural College record was selected to serve as a check station in this area of the

State. The weather station has been at the College since 1 January 1892 and records have been continuous and of excellent quality throughout the years. The equipment has been exposed at various sites on the campus. However, due to the urban nature of the site, the progressive building program at the College, and the steady growth of the nearby city, as well as the ever-increasing area in the valley brought under irrigation, the environment of the station has changed considerably in the past half century.

Values were computed for these two stations on the same basis as for the other stations considered and these values are plotted on Chart II. Several interesting variations are noted in these graphs. At Ft. Bayard, the annual temperature trend is quite similar to the northeastern stations until the early 40's after which the weather seemed to remain relatively cool at Ft. Bayard, while northeastern stations were showing a marked rise in temperatures. This distinct discontinuity was so evident that a careful study was made of the temperature records at Ft. Bayard for the last 15 years of the observational period. This study led to the conclusion that temperatures, and particularly winter temperatures, during the past 10 years or so have been lower at Ft. Bayard than should be expected in their relationship to records made at the other stations. In reviewing the history of the station it was found that in 1944 the equipment was moved from the parade grounds to a site near the main entrance to the hospital grounds. The new location was about one-half mile distant and slightly lower than the earlier location. While such a minor move would not normally be expected to result in a noticeable temperature difference, in this instance temperatures, and especially winter temperatures, have been considerably lower at the new location than at the earlier site. This apparent discontinuity illustrates the importance of making every effort to continue stations at the same location, as even minor moves may reduce the value of the records as indicators of long range temperature trends.

At Agriculture College probably the outstanding feature of the plotted record is the marked uniformity of the temperature curve during the past 40 years. There has been no outstanding warm or cold period at this station so evident in the records at other locations. During the first few years of the period under consideration the temperature record conforms very closely to the record at Ft. Bayard, but neither the cold period so evident at other stations in the 20's or the warm era of the 30's show up to any degree in the Agricultural College records. Nor is there any marked rise in temperatures at this station during recent years. It is difficult to say with certainty whether this is a true picture of the temperature trend in this section of the State or not. However, after comparison with the records of other stations, the question arises as to whether the urban location within a large area of irrigated farm lands may not have tended to smooth out all temperature abnormalities.

The precipitation records at these southwestern stations conform more closely to the general picture shown at northeastern stations. The drought of the mid-30's was not so severe in this part of New Mexico, and while 1941 produced almost twice the normal annual rainfall at the southwestern stations, the years prior to and subsequent to 1941 were not unusually wet, so that the smoothed curves do not show a marked rise in rainfall in the early 40's. The fact that recent years have been drier than any previous period in the past half century is clearly evident in this area and it seems that the statement "New Mexico is experiencing its severest drought in 50 years" can be accepted without question.

In conclusion, there seems to be no doubt but that the northeastern part of the State has been getting progressively warmer and drier for many years. And so far as rainfall goes, this same conclusion seems to hold true for the southwestern part of New Mexico. However, when it comes to the temperature trend in the southwest, no such clear-cut statement can be substantiated. The author believes, nevertheless, that if suitable records were available from stations free from all influences other than climatic changes, the same temperature trend would show up in this section that is so obvious in northeastern areas.

IGY Antarctic Weather Central personnel at Little America V. From left to right: T. Gray, K. Morley, H. Van Loon, J. Alt, H. Cochrane, B. Lieske, W. Moreland (the author), J. Alvarez, V. Rastorguev, and H. Wexler (Chief Scientist for U. S. IGY program). Photo by P. Humphrey.

Inside Antarctica No. 3— The Weather Central at Little America

W. B. MORELAND, *U. S. Weather Bureau*

DURING the planning of the IGY Antarctic program in early 1955, the need for a weather central in the Antarctic was recognized. Air operations as well as over-snow traverses would require accurate weather analyses and forecasts in order to assure a maximum degree of safety for operating personnel. The weather central would also serve as a clearing house for all the raw Antarctic weather reports. These would be screened and transmitted by radio to other weather services in the Southern Hemisphere in order that they could be employed in improving and extending weather analyses and forecasts.

The world IGY coordinating body, CSAGI, asked the United States to accept the responsibility of operating an Antarctic weather central during the IGY. The U. S. National Committee accepted and plans were made to locate a weather central at Little America V.

Since ten different nations were planning to establish bases in the Antarctic, a great deal of cooperation was required to make possible the successful operation of a central. The international aspect came clearly into focus in the staffing of the station. In addition to U. S. meteorologists, representatives from Argentina, Australia, France, New Zealand, South Africa, and the U.S.S.R. participated in the program. The wintering-over staff for the first year, 1957, consisted of four U. S. meteorologists, one Argentine and one Russian. During the 1956–57 summer period the staff was augmented by an additional American and one from New Zealand; the 1958 wintering-over group included one Australian and one French meteorologist. During the 1957–58 summer period a South African also participated.

Prior to their departure for the Antarctic both groups of American meteorologists were given a two-month course in Southern Hemi-

sphere analyses, held at the Weather Bureau Central Office in Washington, D. C. These programs gave the men an opportunity to become familiar with the problems related to Southern Hemisphere analysis as well as a chance to become acquainted with their colleagues with whom they would be closely associated for a fourteen-month period.

The members of the first wintering-over group arrived at Little America in the latter part of December 1956. At this time the camp was overcrowded with U. S. Navy construction personnel who were erecting buildings and unloading supplies from cargo vessels. The space which was alloted to the Weather Central was being used as an operational headquarters as well as for housing the amateur radio equipment. These functions later were moved to other buildings.

During the first month and a half in the Antarctic, the duties of the Weather Central personnel consisted principally of loading and unloading supplies from cargo sleds, setting up furniture, and performing many other household duties necessary in establishing a station in this remote region of the earth. By the latter part of February the summer personnel had departed, and the Weather Central was installed in its permanent quarters.

Before the Weather Central could go into full operation, it was necessary to activate the Antarctic communications network (Figure 1), which had been carefully planned by the IGY working group on Antarctic radio transmissions, under chairmanship of A. H. Sheffield of England. Although some changes in the network had to be made during 1957, due to equipment limitations, it was possible in 1958 to start the planned network.

The basic concept of the network operation was based on a mother-daughter relay system. A mother station, on a prearranged schedule, would collect the weather reports from a number of daughter stations, then re-

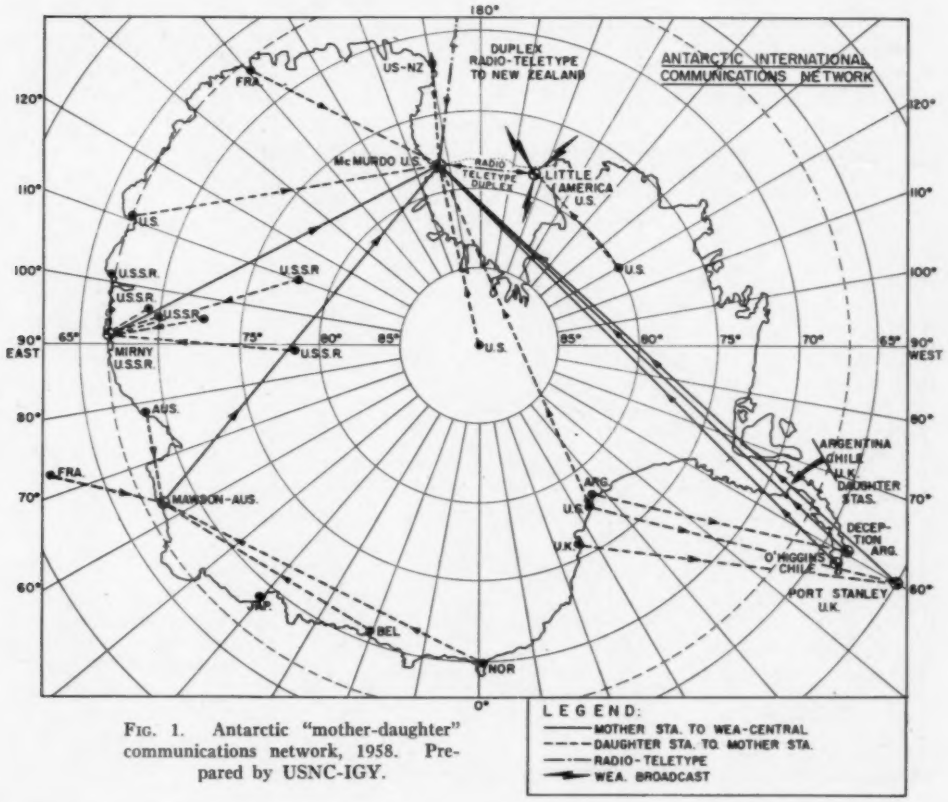


FIG. 1. Antarctic "mother-daughter" communications network, 1958. Prepared by USNC-IGY.

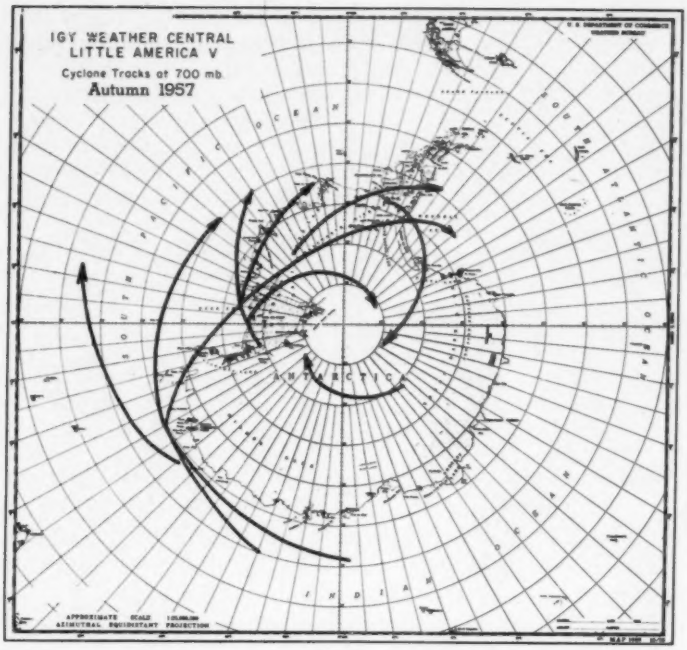


FIG. 2. Autumn 1957 cyclone tracks at 700 mb (after Rastorguev and Alvarez). Due to the high elevation of the interior of Antarctica, the 700-mb chart (approximately 10,000 ft.) comes very close to being a surface chart for much of the continent.

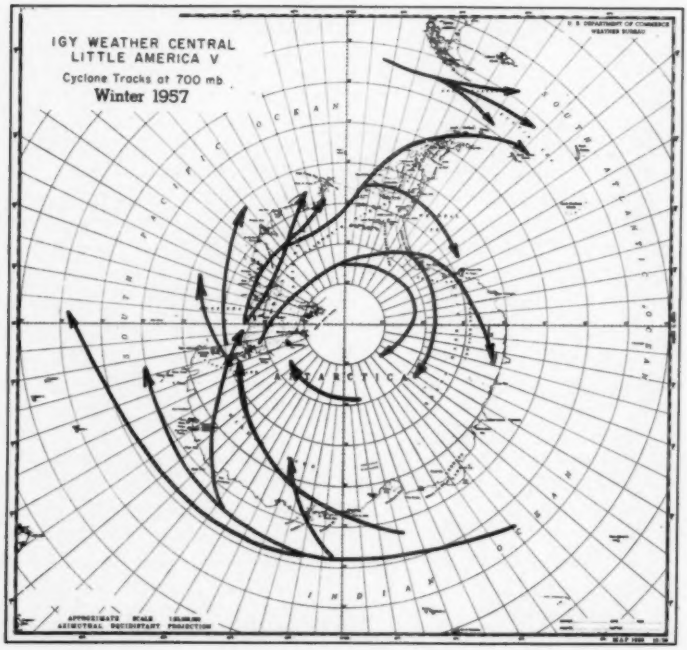


FIG. 3. Winter 1957 cyclone tracks at 700 mb (after Rastorguev and Alvarez).

lay these reports to the radio central at McMurdo Sound where they were collected and relayed to the Weather Central. Due to damage inflicted on the McMurdo antenna field by a blizzard during the middle of May 1957, the mother-daughter network did not get into full operation until late June.

The number of radio schedules for the transmission of weather reports was dependent on the size of the station. Smaller stations with only one radio operator could maintain three transmission schedules per day while larger stations were able to transmit eight times per day. Schedules were arranged to be as close as possible to the synoptic map times of 0000, 0600, 1200 and 1800 GMT.

At Little America weather data broadcasts from Southern Hemisphere countries were intercepted. Weather Central personnel prepared Antarctic data collectives which were broadcast four times daily. Upper-air and surface analyses were transmitted once a day. On 3 June 1957 a unique radio transmission, the first weather maps ever to be transmitted from the Antarctic continent, were sent from Little America direct to Washington, D. C., via radio facsimile.

The Weather Central analysis program consisted of four surface charts, two 700-, 500- and 300-mb constant pressure charts and one 50-mb constant pressure chart per day. Pseudo-adiabatic charts were plotted for all the Antarctic upper-air reports. Vertical time sections of temperature, wind, etc., were analyzed for nine Antarctic stations. In addition to the analysis programs, special research studies were made on the Antarctic weather and atmospheric circulation features.

One of the many interesting weather situations which were encountered in the Antarctic occurred during the middle of May 1957. During this period on May 11th a surface temperature of $-1°$ C ($+30°$ F) was recorded at Little America while, at the same time, a surface temperature of $-74°$ C ($-100°$ F) existed at the South Pole. The surface temperature at Little America then rose twenty-four degrees with the approach of an occlusion on May 9th. Although the temperature fell eleven degrees on the 10th, it rose eighteen degrees with the passage of another frontal system on the 11th. During this same period at the South Pole, clear skies and light winds permitted the temperatures

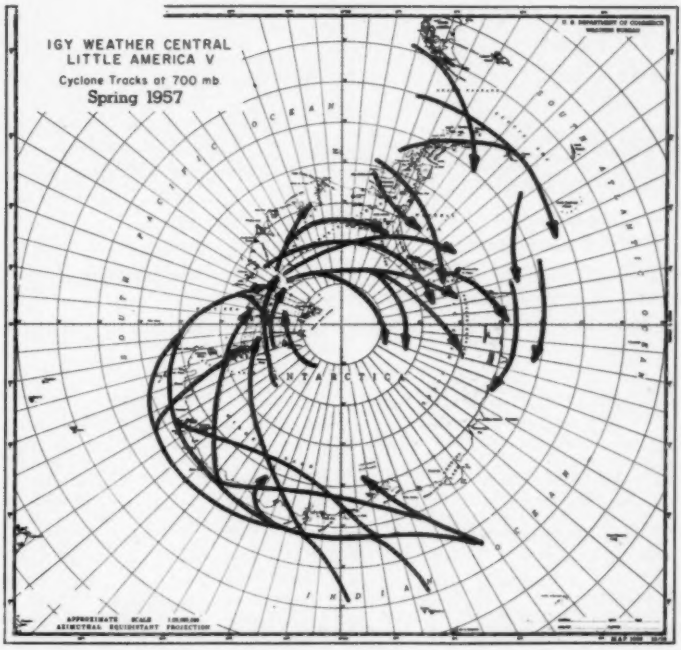


FIG. 4. Spring 1957 cyclone tracks at 700 mb (after Rastorguev and Alvarez).

to drop steadily, reaching a minimum of − 74° C on the 11th. On the 12th an upper frontal system caused cloudiness and precipitation as it moved across the Pole. The surface temperatures rose twenty-two degrees in a twenty-four hour period. Since a similar combination of meteorological events did not occur again during 1957, this seventy-three degree temperature gradient between the Pole and Little America provided the strongest encountered during the year.

Vertical time sections for the Little America and the South Pole stations for the period 7–19 May reveal the interesting fact that it is possible for fronts to penetrate deep into the interior of the Antarctic continent. However, experience indicated that only the more intense frontal systems were capable of maintaining their identity all the way to the Pole. Temperature contrasts across the fronts weaken as the air mass is modified during its movement across the extensive Antarctic ice sheet. Generally, only the upper remnants of the frontal system are evident by the time they reach the Pole. They are, however, of sufficient intensity to cause cloudiness and precipitation over the South Polar Plateau.

Preliminary circulation studies made by Rastorguev and Alvarez (1) indicate that the interior portion of western Antarctica may be a more stormy region than the interior of the eastern half of the continent. As shown by the 700-millibar cyclone tracks, a major storm path is found from the Ross Sea through the Marie Byrd Land and Ellsworth Highland regions into the Weddell Sea. Cyclones moving along the coast of eastern Antarctica usually did not penetrate deep into the interior until they reached Wilkes Land. The presence of a semipermanent anticyclone over the eastern interior of the continent tended to block the entry of the cyclones until they had passed the 90° E meridian. The fact that the interior of eastern Antarctica is comparatively free of storms and cloudiness is one of the contributing factors in making this area one of the coldest regions on earth. Since the elevation of this region averages 10,000 feet above sea level, clear skies permit a large amount of heat to escape from the surface through the dry, transparent atmosphere. Record low temperatures have been reported by the U.S.S.R. stations located in this region. To date the lowest temperature reported is − 125° F at Vostok (78° S, 107° E, elev. 11,200 ft.) on 25 August 1958.

Perhaps one of the greatest difficulties of weather central operation in the Antarctic is the occurrence of radio fade-outs. At least one major fade-out occurred each month and would last from three to five days. During these periods radio contact with the outside world ceased. In the more severe periods it was even impossible to communicate with neighboring Antarctic stations. Weather data could not be received during the course of this type of communication isolation, and the continuity of map analysis was destroyed. With the return of normal radio communication conditions, a period of one to two days was needed to restore continuity.

Other factors which contributed to operational problems were limited working space, confinement, and the rather rigorous climate. Although the working conditions at Little America may have at times seemed severe, the experiences and achievements gained there will remain for many years in the memories of the men who worked in the first Antarctic Weather Central. It is hoped that the pioneering work begun there during the IGY will be continued at a weather central located in a Southern Hemisphere country.

WEATHER CENTRAL STAFF

1956–1957	*1958–1959*
W. B. Moreland, U.S.A., MIC	T. I. Gray, Jr., U.S.A., MIC
J. A. Alvarez, Argentina	J. Alt, France
T. Edie, New Zealand (summer)	A. J. Arruiz, Argentina
J. Krank, U.S.A.	P. D. Astapenko, U.S.S.R.
B. Lieske, U.S.A.	H. B. Cochrane, U.S.A.
V. I. Rastorguev, U.S.S.R.	K. Morley, Australia
M. Rubin, U.S.A. (summer)	N. J. Ropar, U.S.A.
R. C. Taylor, U.S.A.	C. F. Fopay, U.S.A.
	H. Van Loon, South Africa (summer)

1. Rastorguev, V. I., and Alvarez, J. A., "Description of the Antarctic Circulation Observed from April to November 1957 at the IGY Antarctic Weather Central, Little America Station." *IGY World Data Center A, National Academy of Sciences, General Report Series, Number 1,* 1958.

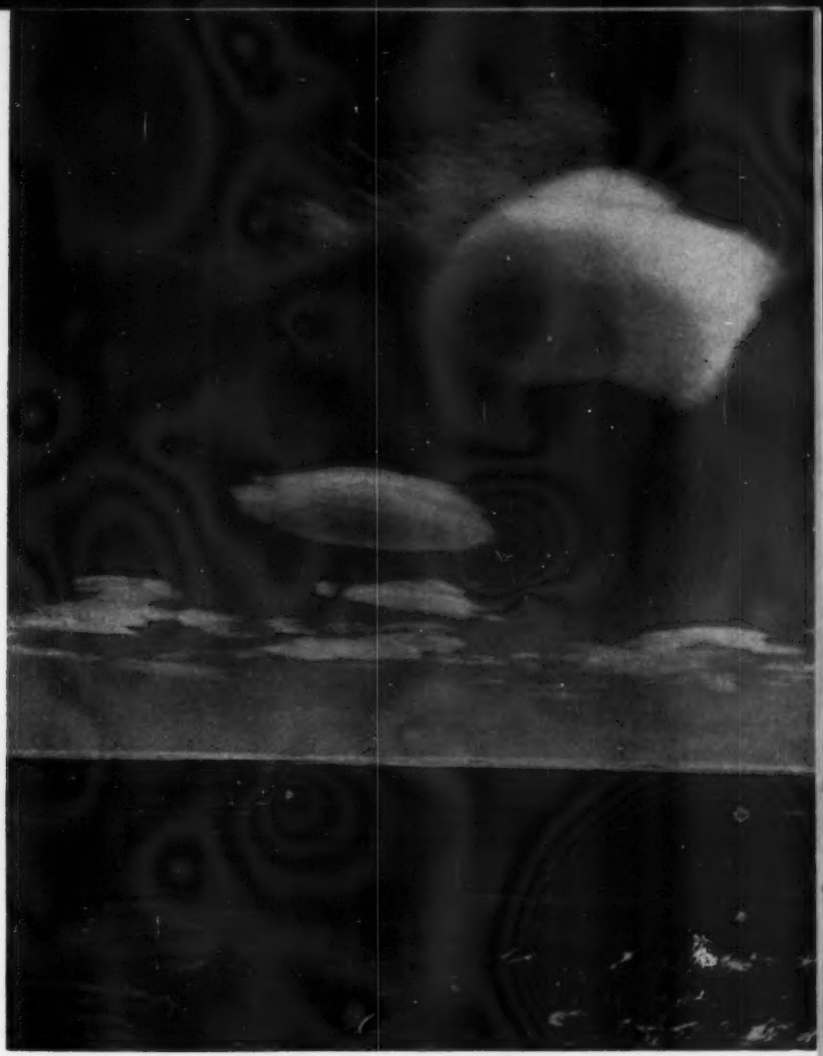


FIG. 1. A group of "grindstone" clouds over the Colorado high plains, just south of Boulder. Such clouds are quite common in this area during the winter season.

Areas of Occurrence of "Grindstone" Clouds

RONALD L. IVES, *Palo Alto, California*

DURING the past decade, observers in many parts of the United States have reported and photographed circular and ball-shaped clouds, and have described them as almost everything from interesting cloud formations to space vehicles from the lost Kingdom of Mu. Excellent photographs of these clouds have been published in *Life Magazine* (1) and *Weatherwise* (2). Two additional examples, photographed in the vicinity of Boulder, Colorado, are presented here (figs. 1 and 2).

Although these clouds are only recently of public interest, they are by no means a new phenomenon, having been reported in the Colorado high plains area at frequent intervals for almost a century. In this area they are commonly called "grindstone" clouds. Likewise, in the valleys just east of the Sierra Nevada of California, they occur quite

FIG. 2. "Grindstone" clouds as seen in the Colorado foothills near Boulder.

frequently. Clear descriptions of these clouds and their common mode of formation are given by Humphreys (3), and the names *cumulus lenticularis, stratus lenticularis,* and *standing clouds* assigned them in technical literature.

Wherever observed, these clouds have the interesting property of retaining their geographical position for considerable periods of time, despite high winds at all levels. Aerographic studies show that these clouds are dynamic entities, like a waterfall, and not static entities, like an ordinary cumulus or "Grant's Tomb." When a wind is driven over a mountain barrier, it is commonly thrown into damped standing waves, so that air to leeward of the barrier has a definite oscillating vertical motion, in addition to its original horizontal motion. Adiabatic heating and cooling take place during this motion, so that, through a wide range of temperatures and relative humidities, condensation takes place at the peak of each wave.

In consequence of this motion, the cloud represents the peak of a standing wave to leeward of the obstacle; and, so long as the wind continues, the cloud will be maintained, with attrition by downward air motion (and warming) being balanced by alimentation by upward air motion (and cooling). Stratification of these clouds is not at all uncommon; and differential air motion within them, due

to laminar flow, is the usual situation. Severe icing conditions have been noted several times while flying near and through such clouds near Laramie, Wyoming.

General theory of air motion over large obstacles, such as high mountain ranges, has been developed mathematically by Paul Queny (4); and general validity of Queny's work has been demonstrated by field studies of chinook winds in Colorado (5) and California (6). In very general terms, in view of the theoretical and observational data contained in these studies, we should expect reports of lenticular, standing, "grindstone," and similar clouds from all areas to leeward of high mountain ranges; and particularly from all areas subject to chinook and similar winds.

A study of available reports, summarized in figure 3, shows that this is not entirely the case. The material here presented is based on personal observations, reports by trained meteorologists, published data, and *clear* photographs of standing clouds, many of them presented as photographs of "flying saucers." It seems probable that some of the data hiatuses on this map represent lack of reports, rather than lack of occurrences. This seems particularly probable in the case of the Black Hills area of South Dakota, where chinook-like winds and their accompanying rapid temperature rises are known to occur several times yearly.

It is interesting to note that the areas of occurrence of these standing clouds partially overlap those areas from which "flying saucers" are most frequently reported. Additionally, in a large collection of photographs of alleged "flying saucers," approximately

(*Continued on page 218*)

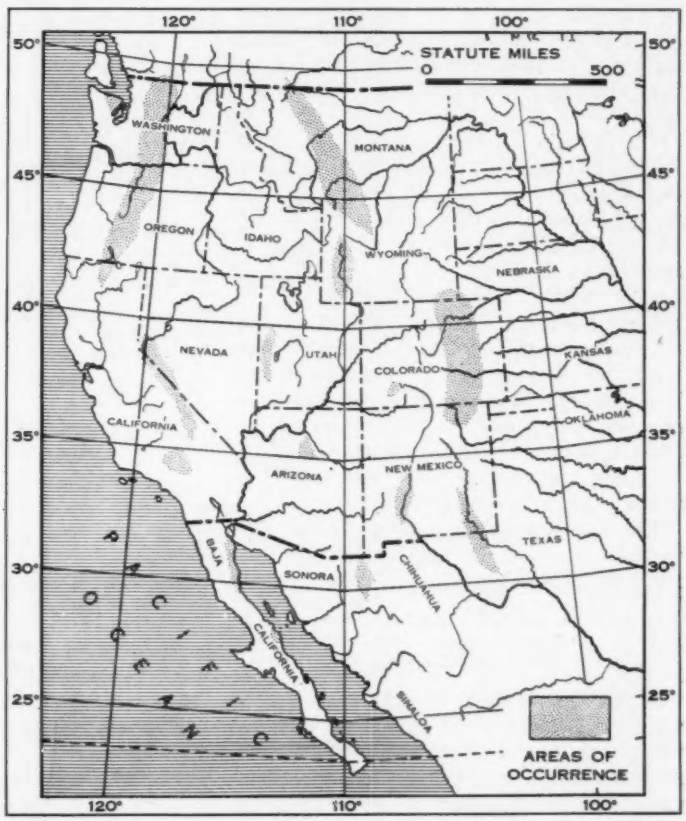


FIG. 3. Summary map of the western United States, showing areas from which "grindstone" and similar clouds have been reported.

Weather Rambles

IVAN W. BRUNK
U. S. Weather Bureau
Chicago, Ill.

POGONIP

THE term "pogonip" does not refer to a drink by a certain comic strip character, but it is a meteorological term used to describe a rather uncommon occurrence—frozen fog. The word is of American Indian origin and is used in connection with frozen fogs of fine ice needles which occur in the mountain valleys of the western United States. Frequently this frozen fog appears early in the morning and disappears before noon, but when there is no wind the pogonip may linger for a number of days. On such occasions the sun is hidden and the frozen fog deposits a coating of ice needles several inches thick on trees, bushes, fences, buildings, men, and cattle.

The pogonip has become noted because of the Indian tradition that breathing the fog is very injurious to the lungs. While it is generally believed that there is no basis in fact for this belief, there are some accounts of deaths from the frozen fog. Near the end of the last century a party of five in North Park, Colorado, became sick with violent coughs and fever after passing into the pogonip. One of the five was reported to have died within 24 hours, and the others recovered only after long sickness. During a winter previous to this occasion, a whole Indian tribe in Wyoming was supposed to have died from the effects of pogonip.

This is perhaps the reason some Indians are more afraid of pogonip than rattlesnakes and call it the "white death."

WEATHER SAYINGS

Most people believe it was Mark Twain who said "Everybody talks about the weather but nobody does anything about it." It was not Mark Twain, but Charles Dudley Warner who made this statement in an editorial in the Hartford *Courant* about 1890. However, Mark Twain did have some things to say about the weather—One of his remarks: "Weather is a literary specialty and no untrained hand can turn out a good article on it."

Other statements concerning weather or climate by famous persons include:

O'Henry: "We may achieve climate but weather is thrust upon us."

Thomas Jefferson: "I wonder that any human being should reside in a cold country who could find room in a warm one."

Bill Nye: "Winter lingered so long in the lap of spring that it occasioned a great deal of talk."

William Shentstone: "There is nothing more universally commended than a fine day—the reason is that people can commend it without envy."

A most applicable quotation is by Don Marquis, which would also apply to weather: "Dont cuss the climate—it probably doesn't like you any better than you like it."

LIGHTNING DEATH DURING KITE FLIGHT (OR RADIOSONDES ARE SAFER)

In connection with the item, "Ben Franklin Was Lucky" in the June 1958 issue of *Weatherwise*, we are indebted to M. Oliver Asp, Weather Records Processing Center, Kansas City, Missouri, and F. J. Bavendick, Meteorologist in Charge, U. S. Weather Bureau, Bismarck, North Dakota, for information concerning a fatality among the ranks of the pioneer kite flyers.

The following appeared in the *Monthly Weather Review* of October, 1919: "Mr. Charles H. Heckelsmiller, laborer, was killed by lightning at Ellendale, North Dakota, on

August 28, 1919, while assisting in a kite flight. Immediate efforts for rescuscitation were made and two physicians were on the scene within 15 minutes. A severe burn was found across Mr. Heckelsmiller's chest and on the inner side of his right wrist. The kite flight was nearly completed and three of the six kites had been landed. It appears that Mr. Heckelsmiller was holding a splice wire in his hand and was standing close to the main kite wire when the flash occurred. At the time of the flash two employees were in the reel house and they state that the house was filled with flame. A line of sparks resembling a huge skyrocket was seen to follow up the wire[1] and these set the grass beneath on fire, as the ground was very dry, no rain having fallen for nearly two weeks. About 1,750 meters of wire were out at the time, and it was completely fused in the air. This is the first accident of its kind that has occurred to an employee of the Weather Bureau during the period of about 25 years, in which the Weather Bureau has engaged in kite observation work.

Weather Oddities

1. It is rather well known that cold air is heavier than warm air, but it is also a fact that dry air is heavier than moist air—at the same temperature and pressure.

2. The capacity of air to hold water vapor is greater at higher temperature and this capacity doubles for every 20 degrees in temperature.

3. It is estimated that an average of approximately 45,000 thunderstorms occur in the world each day. An average of about 1,800 are in progress at any given time.

4. If all the remaining ice sheets and glaciers in the polar regions and elsewhere in the world melted, the level of the oceans would rise between 150 and 200 feet. During the last glacial period when there was much more ice over land areas the level of the oceans was about 450 feet lower than at present.

5. In the atmosphere at heights of 4 miles or more it is usually colder over the equatorial regions than over the polar regions. At a height of about 7 miles the temperature is 90 or more degrees below zero above the equator. At the same elevation over the poles the temperature averages about 20 degrees higher.

6. The Fahrenheit and Centigrade scales are used to measure temperatures. On the Centigrade scale the freezing point of water is zero and the boiling point is 100. At only one point—40 below zero—are the values of the two systems the same.

7. Forty degrees below zero (F. and C.) is just below the melting point of mercury. Therefore, headlines which indicate "mercury drops to 40 (or more) below zero" cannot be true, since mercury would be in a solid state before these temperatures were reached. Furthermore, it is for this reason, and others, that alcohol thermometers are used to indicate minimum temperatures.

8. Heat is released in the atmosphere when rain falls. One inch of rain falling over an area of one square mile releases the same amount of heat as the burning of 6,500 tons of coal or 1,000,000 gallons of fuel oil.

9. The energy released in the average thunderstorm is greater than the explosion of a large number of atomic bombs. It has also been computed that the energy released by a typical hurricane in one second is greater than that produced by several atomic explosions.

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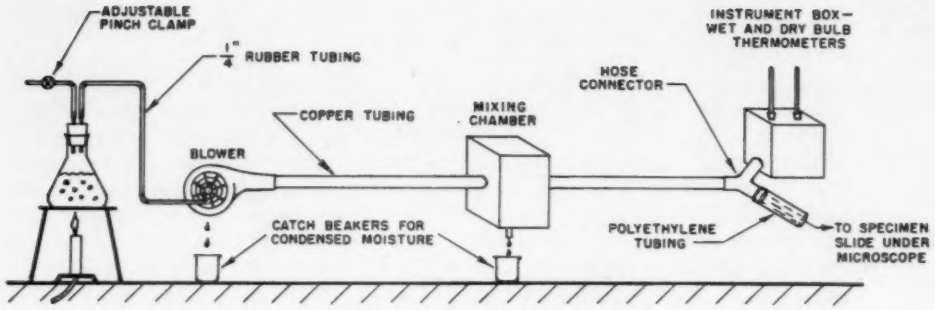
[1] I observed a similar line of white-hot beads when about 1,600 meters of wire was fused by lightning during a kite flight at Blue Hill Observatory, Mar. 6, 1913. The thunder was an *even* peal, since the lightning producing it had followed the smooth curve of the wire.—C. F. Brooks"

Weatherwise Ten-Year Index

A full 20-page index of volumes 1–10, 1948–1957, has been prepared and will be issued in January. It will contain a listing of all articles of lasting interest, as well as book reviews and climate notes, arranged according to both author and subject. Copies of the index will be available through the American Meteorological Society, 3 Joy Street, Boston 8, Mass.



Variable Humidity Apparatus.

Condensation Nuclei Experiments with Simple Apparatus

JAMES E. JIUSTO AND ROLAND J. PILIÉ,
Cornell Aeronautical Laboratory, Inc., Buffalo, New York

THE condensation process runs the gamut from "sweating" of a cold beverage glass on a humid summer day to developing cloud formations aloft. It has long been a subject of interest to both the casual and technical observer. Ever since the independent discoveries of Coulier (1875) and Aitken (1880) disclosed that nuclei upon which water vapor could condense were essential to the process, considerable study has been devoted to these microscopic particles. By means of controlled humidity conditions information can be obtained concerning the types and characteristics of nuclei present in the free atmosphere. Much elaborate equipment has been devised to perform such experimentation. This article presents a description of simple apparatus that can be readily duplicated by the student meteorologist for close-up observation of the condensation phenomenon or by the research physicist for obtaining reproducible nuclei measurements.

THEORY

Condensation nuclei are classified as either hygroscopic or non-hygroscopic, the former inducing condensation at relative humidities less than 100 per cent and the latter at relative humidities greater than 100 per cent. Since the hygroscopic variety is generally recognized as the more important type in cloud formation (1), our apparatus was designed to generate only sub-saturated conditions. For every hygroscopic substance, a fixed humidity point exists at which the particle will convert from the solid to liquid phase. S. Twomey (2) has shown this point to be well defined, thereby allowing for approximate identification of the substance by noting the exact humidity that fosters conversion. For example, condensation occurs on sodium chloride nuclei at a relative humidity of 72–75 per cent but with more hygroscopic nuclei such as lithium chloride at a relative humidity as low as 11 per cent. The effect of variable temperature on the phase change point is negligible over normal laboratory operating conditions. Controlled humidity experiments, therefore, enable one to ascertain (1) the hygroscopic or non-hygroscopic nature of a particle, (2) the point at which a hygroscopic nucleus promotes condensation and (3) an inference as to the chemical composition of a hygroscopic particle by comparison of its phase change point, expressed in per cent relative humidity, with tables of known equilibrium humidities for saturated aqueous solutions.

Description of the Apparatus

The equipment shown in figure 1 consists of a forced air system with variable, pressurized-moisture input. By controlling the amount of water vapor injected into a stream of rapidly moving ambient air, a resultant air current of any desired relative humidity (within discussed limitations) can be established. An electric hair dryer acts as an ideal blower in coursing ambient air through four feet of copper tubing (⅞ inch outside diameter). The air stream is divided into two branches, one leading to an instrument box containing wet and dry bulb thermometers, and the other being directed onto the specimen slide. A 12-inch length of polyethylene tubing forms a flexible final link in the circuit. With this exhaust tube kept close to the slide, no entrained outside air enters the test zone. An intermediate mixing chamber insures uniform distribution of water vapor in the "dry" air. The mixing chamber and instrument box can be fabricated from available containers. Wooden cigar boxes, whose interiors are coated with a moisture repellant rubber base paint, will do nicely.

Water is boiled in a 1,000 ml Erlenmeyer flask over a bunsen burner or a three-speed electric hot plate and the vapor allowed to escape via two exits. The first hose connection is fed into the main air current at the intake opening of the hair dryer, the opening facing downward so that condensed moisture will fall into a catch beaker and not penetrate to the motor. The second hose, equipped with an adjustable pinch clamp, is exposed to the free atmosphere. By gradually closing this second outlet, increasing amounts of water vapor can be diverted to the central air stream so that relative humidities up to 98 per cent can be established. Room humidity determines the minimum value that can be achieved. Careful manipulation of the pinch clamp results in regulated humidity increments as small as 1 per cent.

Sampling Techniques

Condensation nuclei can be collected by exposing clean glass microscope slides to the air. With an optical microscope capable of approximately 430 power magnification, it is possible to observe particles greater than 0.5 micron diameter. Lower power microscopes illustrate the condensation process equally well, though observation is restricted to larger nuclei. A second collection method involves whirling a slide in a water or ice cloud produced by breathing or ejecting steam into a deep freezer. The ice particles accumulated in this way are permitted to melt and evaporate, leaving a residue of condensation nuclei (see figure 3a). Since the melt of many ice particles becomes mixed, some of the dissolved hygroscopic nuclei undoubtedly recrystallize into fewer, larger masses of material than initially engaged in the condensation process. This method allows for rapid collection of large numbers of nuclei. A T-shaped metal device that holds two slides at the cross-bar extremities has been constructed for rotation in a 1700 rpm electric hand drill. By utilizing narrow slides, about ¼ inch wide, such a simple arrangement provides a good impingement collector.

Fig. 2a. Sodium chloride crystals at 68% R.H.
Fig. 2b. Initial conversion to liquid at 72% R.H.
Fig. 2c. Complete dissolution of nuclei at 75% R.H.

Experiments

After the nuclei are gathered on the specimen slide by one of the techniques outlined above, they are ready for exposure to air of varying humidity to determine their degree of hygroscopicity. As a hygroscopic particle's critical humidity value is reached, its sharp edges will become diffuse, indicating wetting of the extremities. Steady dissolution of the nucleus will follow until just the liquid phase is present. Relatively small nuclei, requiring little dissolving time, appear to undergo this transition almost instantaneously, whereas larger particles permit discernment of the gradual conversion. The transition time is also a function of the rate at which the critical humidity value is surpassed. Raising the humidity in very small increments provides maximum observation of the process. It is thereby possible to arrest this progression at the solid-liquid equilibrium point so that a partially dissolved nucleus will persist within its liquid environment until more moist air is introduced. By reading the wet and dry bulb thermometers at the time condensation is occurring, the relative humidities at which the respective nuclei become active are established. Any non-hygroscopic nuclei present will remain solid throughout the imposed range of variable humidity.

Such tests can be made on a daily basis at a given locale to shed light on the types of nuclei present in the atmosphere, their variation with time of day, season, synoptic situation, etc. The piping of ambient air into a cold box and sampling by method two above is recommended, since large concentrations of nuclei can be averaged in a short time.

Common table salt or sodium chloride provides ready access to one of the more abundant and important types of hygroscopic nuclei known to exist in the atmosphere (3). Representative sized nuclei (.5–50 microns diameter) can be produced by grinding table salt between two microscope slides. When analyzed in the described apparatus, the particles will be seen to foster condensation at relative humidities of 72 to 75 per cent, as shown in figure 2a–c. This vivid demonstration with sodium chloride also serves as an excellent calibration check for the apparatus. The types of experiments that can be performed are numerous. Figure 3a shows a number of particles that were collected from a condensation trial produced by burning 100 octane fuel in a laboratory cold chamber. At 39 per cent R.H. all the particles were in the solid state. Figure 3b indicates that at 51 per cent R.H. considerable nuclei had fostered condensation and had converted to the liquid phase. Many other particles, however, remained solid and were either less hygroscopic or completely non-hygroscopic. By compar-

(Continued on page 217)

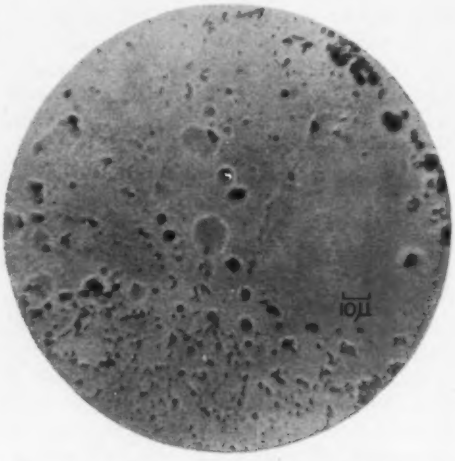


Fig. 3a. Condensation nuclei from laboratory-produced contrail. All particles are in the solid phase at 39% R.H.

Fig. 3b. Partial conversion to liquid phase at 51% R.H.

Description of Fraser, Colorado

KENNETH TILLOTSON, *U. S. Weather Bureau, Denver*

ONE of the most often-mentioned cold spots in the nation is Fraser, Colorado. Since it is included so frequently in routine weather bulletins and broadcasts, many people have mistakenly come to believe that Colorado as a whole is an unusually cold state.

During the winter season Fraser, Colorado, and Big Piney, Wyoming, compete for the rather dubious honor of being the "Nation's Icebox." Opinions differ as to whether this kind of publicity is adverse or good. Political influence was at one time exerted in Wyoming to close the Big Piney station because of its often-mentioned low temperatures and the adverse publicity affecting commercial interests in that state. So far, at least, no such attempt has been made with respect to the Fraser weather station.

Fraser is a relatively small mountain town of approximately 350 residents, and is located in a pocket literally a stone's throw from the Continental Divide which lies 10–15 miles to the east. The above photograph shows the Continental Divide looking east-northeast from the town. It is nearly surrounded by 13,000-foot mountains and has an elevation of 8,560 feet. It is 40 miles west-northwest of Denver as a jet flies; however, by auto it is 72 miles since one must climb from mile-high Denver on U. S. 40 over Berthoud Pass at an elevation of 11,312 feet then down into the valley on the western slope.

It is directly under the airway from Denver to Los Angeles. It was established as an aviation reporting point in 1945. Regular reports are made day and night at 2-hourly

intervals. All elements reported are considered very important, but perhaps the most significant are the remarks. Clouds, even scattered in coverage and 4,000 feet above Fraser, might at first indicate excellent flying conditions over the Continental Divide, except for the fact that the clouds frequently are found lying principally on the mountain ridges and therefore obscure them. These remarks concerning the clouds as to whether or not they obscure the mountains on the western side of the Continental Divide are invaluable to private pilots who wish to cross the mountains. It is not uncommon to have light snows falling from 2,000–3,000 foot ceilings due to the pronounced orographic effect of the normal westerly flow which prevails at the upper levels. The surface wind is ordinarily light except immediately following a new push or cold air from the west, when light to moderate west or northwest winds prevail for a short time.

What do the residents do when the bottom drops out of the thermometer? They just don't pay much attention to the cold. There the cold is merely routine. Some say that they rarely look at a thermometer unless it is 25 degrees below zero or colder. A number of people there have said that "It seems twice as cold in Denver when it is 20 above than it is here in Fraser at 20 below. It is so dry up here you don't notice the cold." The principal of the school says that the only absenteeism is due to illness and not to cold weather. The record low temperature came on Christmas 1924 when the "mercury" fell to 50 below. However, meteorologically informed people realize that alcohol thermometers must be used to measure such low temperatures since mercury freezes at 40 below.

There are numerous such "high mountain valleys" or pockets where comparable and even much lower minimum readings are observed. Fraser is unique in that its reports are entered regularly on the Service A teletype network. Many of the others are climatological stations which submit their readings monthly.

During the colder season the night temperatures reach such low values due to a combination of factors. Fraser lies in a small valley or pocket into which cold air drains. Under clear skies and over the snow cover on the ground, maximum radiation is permitted. The drainage out of this small basin is rather restricted. This contributes to the accumulation of extremely cold dense air at the surface. An atmospheric sounding during one of the cold nights would undoubtedly indicate a very shallow layer of cold air. It is not uncommon to observe the mid-morning temperature shoot rapidly to a value 30 to 40 degrees above its early morning minimum, with the maximum at times as much as 50 degrees above the minimum.

The town is made up of loggers, trappers, and people in business serving travelers on highway U. S. 40, which is one of the year-around connecting links between Denver and Salt Lake City.

In the summer the tourists come. The most important ones during a number of recent years were President and Mrs. Dwight Eisenhower. In the winter the skiers come. Then the town is nestled in a broad white saucer of snow surrounded by the timbered slopes of the mountain peaks. It is common for the snow depth to be from 7 to 10 feet on the nearby slopes surrounding the town. The logging operations go on winter and summer. For entertainment at night, many watch television in spite of the fact that the 13,000 foot range separates them from the transmitters.

The present observers, Mr. and Mrs. Ronald Tucker, have been taking the observations at the two-hourly intervals for the past four years with but few missed observations.

Weather Workbook

The Weather Workbook has recently been published under the editorship of Professor Fred W. Decker of Oregon State College. It is designed as supplementary material for a first year college course. The book contains about 50 sheets of charts and instructions for plotting and analyzing maps and charts. Available at $1.60 through—Weather Workbook, 827 N. 31st Street, Corvallis, Oregon.

Blizzard of '88

(*Continued from page 190*)

nor ice can be delivered. It is a poor time to get sick, for doctors, too, are without transportation. The dead cannot be buried and funeral homes are filling up. City conditions are bad enough, but one shudders to think of the consequences of the storm in nearby rural communities. You hope those folk have adequate supplies, for many days will pass before country roads are opened up. Fortunately and unbelievably, there are none of the dreaded fires.

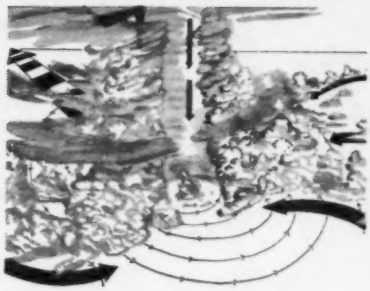
The first train to successfully buck its way through the drifts reached Albany from Schenectady around midnight. It took just seven engines to turn the trick. People are now starting to shake off the effects of the storm and the town is coming to life once more.

After the sun has set this Wednesday evening, you finally realize how tired you are, Barnes. Cat naps are all that you have rationed yourself since Monday. Tonight you will sleep a long sleep in your own soft bed. You've been in charge of this station since 1879 and this is the worst storm you've ever seen. Stately Judge Parker, and other old timers, contend that this is the worst in living memory and you find no reason to doubt them.

Folks are going to talk about this storm for years and years to come; and so long as you live, you will, too. After all, why wouldn't you, it happened at your station during your tour of duty—the Blizzard of '88. PS: Barnes retired the next month.

Oswego Snowburst

Heavy snow squall activity along the lee shore of Lake Ontario in upper New York State dumped record amounts on 6–11 December 1958. The cooperative station at Oswego was buried under a 67-inch total which settled to a 45-inch cover on the 11th. The fall of 33 inches (15″ in three hours) created a new 24-hour mark as did the total snow cover. Retired U. S. Weather Bureau official at Oswego, Elmer Leveridge, could recall no equal during the 88-year history of the local station. Old records indicate a storm there of similar proportions in February 1856.



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Weatherwatch

Data by Office of Climatology, USWB.

Record Heat in West Features Fall

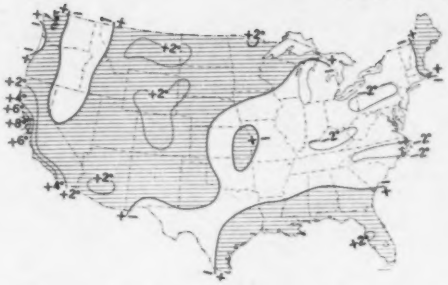
DAVID M. LUDLUM, *Editor*

CIRCULATION—The air flow pattern prevalent during August continued its general features into September. Both months were dominated by an above normal westerly flow which usually tends to keep temperatures over the greater part of the country above average and precipitation below the expected quantities. In general, pressure contours flattened out during September, and we find the streamlines of mean air flow for the month running close to a straight west-to-east alignment for the greater part of the month.

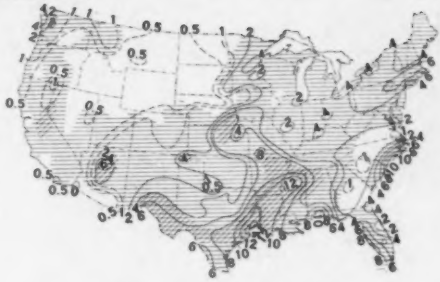
This type of air movement, of course, does not give rise to extensive mixing of opposing air masses, results in rather stable atmospheric conditions and a subsequent lack of front page weather stories. In fact, September did not produce any outstanding single event until the closing days when Hurricane Helene sideswiped the Carolina coast with 100 mph winds. Many stations throughout the country reported near normal temperatures, precipitation with a tendency to be deficient except at coastal locations, and the almost complete absence of severe local storms. In all, it was an excellent month for the harvest in the great grain growing states, and that operation went ahead at a fast pace in September with a bumper crop in sight by the month's end.

The weather story for September conveniently divides into two periods. During the first two weeks the key to the national circulation was held by a ridge of high pressure which built up over the Plateau and Rocky Mountain areas on the 5th and 6th, temporarily ending a period of west-to-east flow which for the first few days of the month had brought mild Pacific Ocean air to most parts of the country. With an anticyclonic block building up over the Plateau, winds on the immediate Pacific Coast became more southerly and a very warm period followed. Eastward in the Mississippi Valley and the Atlantic Coast region air flow on the eastern side of the ridge came from the northwest to move polar air southeastward into the Eastern states.

The temperature departure chart for the week ending September 14th well illustrates how the above described air flow could departmentize the nation thermally. Along the California coast the excess amounted to six degrees and more, and in Montana, where the chinook effect was added to air originally mild, the departures ran as high as 9 degrees. But eastward of a line from Minnesota southwestward to El Paso, Texas, the reverse was true. Polar air flowing down the ridge from Canada dropped average readings east of the Mississippi River at least



Departure of Average Temperature from normal in degrees Fahrenheit. USWB chart.



Total Precipitation in inches. USWB chart.

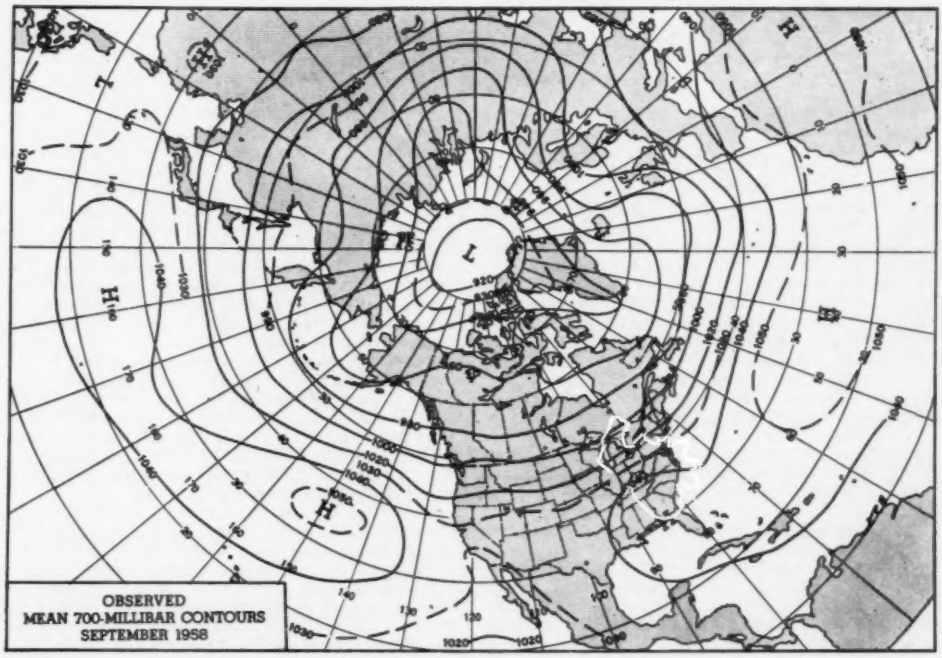
3 degrees below normal and in the central Appalachians to 9 degrees below. Extensive frosts occurred on the night of the 12th and 13th from New England to North Carolina and in the interior of the Great Lakes area as a surface high produced ideal radiation conditions.

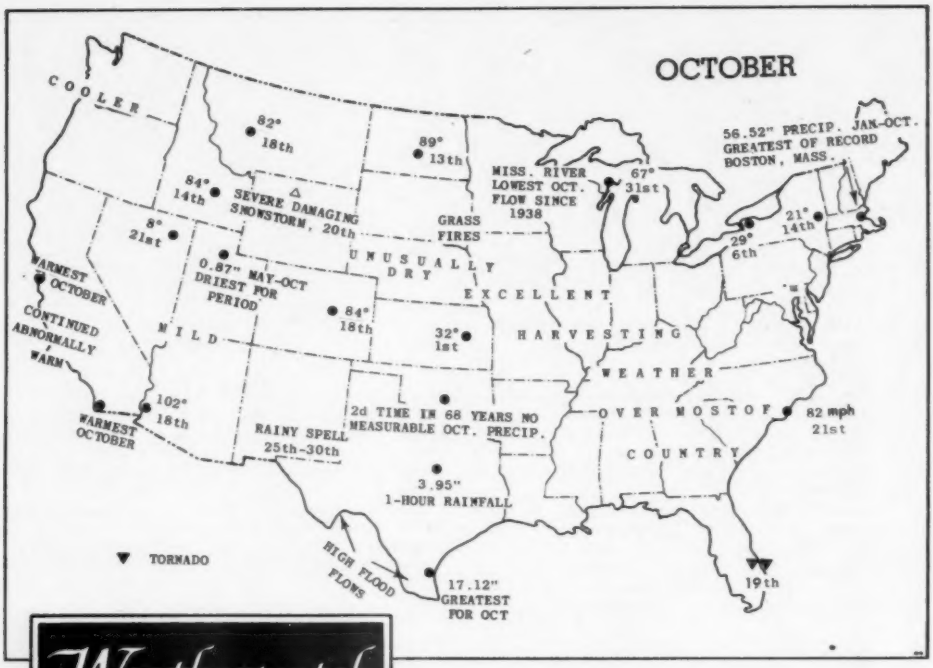
After ten days of low index flow, the westerly winds again shifted into high gear as the above-mentioned ridge moved eastward into the Atlantic Ocean by the 16th. For the following ten days pressure features on the daily weather maps were less pronounced and the great temperature contrasts of the previous ten days disappeared. In general, the eastern part of the country warmed up considerably—the western portion cooled off somewhat with the exception of the California coast where the excessive heat spell continued through the entire month.

The final week produced the most interesting weather map developments of a month which was particularly devoid of other outstanding situations. The noontime plot on the 23rd showed an extremely long surface front extending from Labrador across

(*Continued on page 216*)

The upper-air map below shows the pattern of air flow for September at about 10,000 feet, on which the average weather largely depends. The contours lines represent the mean height of the 700 mb. pressure level. Figures are in tens of feet: 1020 = 10,200 ft., 980 = 9,800 ft., etc. Chart by Extended Forecast Section, USWB.





Weatherwatch

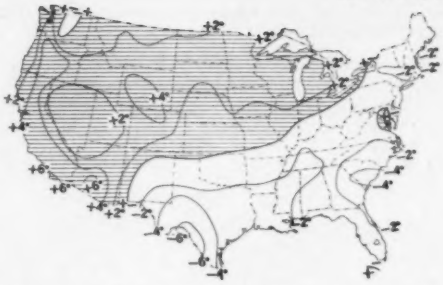
CIRCULATION—The dominance of above normal westerly flow across the continent, which commenced early in August and persisted through September, continued well into October with the major features of the upper-air and surface weather maps remaining largely the same over most of the ten-week period. The familiar pattern of western ridge-eastern trough remained, though the features were not too sharply drawn with a flat ridge over the Plateau states and a shallow trough just off the Atlantic Coast.

The normal high index feature, a deep vortex over the North Pole area, provided the outstanding feature of the North American map. From the polar vortex a trough swung southward over Greenland and Newfoundland, and from time to time tied in with the Atlantic Coast trough which in October had a mean position southward from Maine, east of Cape Hatteras, through western Cuba, and into Central America. This continuing feature of the map had nurtured several tropical disturbances in August and September, provided a northward passage for Hurricane Janice at the end of the first week of October, and set the scene for some unusual cyclonic gymnastics in late October.

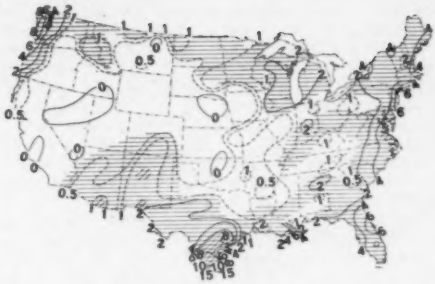
During the first two weeks of October there was considerable cyclonic activity in the Gulf of Alaska which was connected to high latitudes by another southward extension of the polar vortex. Pressure impulses from the Aleutian area low either crossed the mountains as distinct centers or reorganized on the lee side in Alberta and swept eastward across southern Canada in the swift westerly flow. These exerted little influence south of the U. S. border; not until the 18–19th did any general rains spread across the northern border states where rain was now sorely needed. The small ridge over the Plateau maintained clear skies and dry weather throughout the Plateau and Rocky Mountain states, as well as in the western Great Plains, and finally produced a heat spell of record proportions for mid-October.

The period of above normal westerly index continued to rule until mid-month when the weather map began to exhibit some interesting changes. The ridge over the southern Plateau, apparently reinforced from the great Pacific Ocean anticyclone, extended its influence northward and increased in intensity; by the 17th it had reached a maximum position extending its control well into the sub-Arctic of northwestern Canada. This development turned upper-air winds on the western side more to the south, a shift which gave Los Angeles its hottest mid-October day in history. To the east of the strengthened ridge, polar air rushed southeastward in a long trajectory to the Gulf of Mexico and Florida where a developing upper-air vortex signaled the end of the static pressure pattern which had dominated late summer and early fall.

Now with an exchange of tropical and polar air under way, the weather map took on a new look after the 18–19th, and the westerly index of flow declined rapidly during the ensuing period to reach a low point from the 23rd to 27th as the weather picture assumed a wintry appearance. High pressure over central and southeastern Canada put an end to the normal movement of lows across Canada.



Departure of Average Temperature from normal in degrees Fahrenheit. USWB chart.

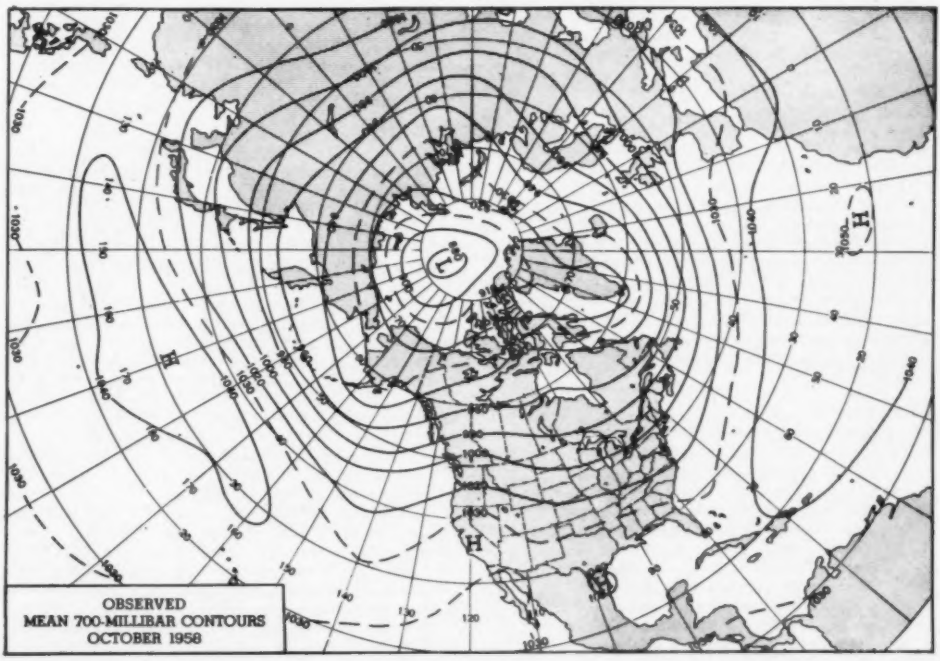


Total Precipitation in inches. USWB chart.

Two centers became stalled, one over the Dakotas and another off the Atlantic Coast; these eventually merged into one system to prolong a series of cloudy, rainy days along the Atlantic seaboard as an easterly circulation out of the Canadian high pushed moist, maritime air from the Atlantic inland. The northern anticyclone drifted slowly southward and southwestward from central Canada into the Mississippi Valley to dominate the entire weather traffic pattern in the closing days of October.

WESTERN HEAT—A heat wave of record proportions gripped the area from California eastward to the Great Plains in mid-October and many maximum and highest-so-late-in-the-season marks tumbled. The prolonged heat spell which had seared the California coastal strip since May spread into the interior of the Southwest in early October as warm anticyclonic conditions aloft kept skies clear and allowed maximum insolation. Another factor entered the situation on the 10th; after a frontal passage had swept southward to the Mexican border and beyond, a thermal surface low established a southeasterly flow from the deserts of Mexico northwestward over the Plateau, bringing a vast surge of warm surface air. This combination resulted in a heat wave unprecedented in intensity for so late in the season.

Yuma, Arizona, set records daily from the 13th to the 18th, and the mercury topped 100° on each day from the 10th through the 18th. The climax came on the 16th with a top mark of 106° On this date and the two following days the readings were the highest ever registered so late in the season.



At Salt Lake City the winds had been in the southeast or south-southeast since the beginning of the month, temperatures mounting daily into the seventies and low eighties. New daily maximum records were created from the 12th to the 19th, except for the 17th when the mark was only equaled. A peak reading of 85° on the 13th was only three degrees behind the all-time October mark, which incidentally was set only the year before—a concrete illustration of the general area warming which has been affecting the Southwest in the past three years.

The strong westerly flow aloft carried the hot air over the Continental Divide, and, with the assistance of additional downslope warming, heat records tumbled on the eastern slope of the Rockies also. Rapid City set new daily maximum figures on the 13th, 14th, and 15th. The top figure in the area appears to have been the 97° registered at Wagner, South Dakota, on the 15th, with marks in the 90's general over the state. As far east as Sioux City, Iowa, the mercury reached the low 90's to set new late season records. Denver's 84° and Cheyenne's 80° on the 18th set new marks for the slopes of the Rockies.

The remarkable heat wave ended with dramatic suddenness on the 19th and 20th as an energetic cold front from the North Pacific Ocean swept inland with a flow of unstable maritime air. The temperature decline at Ely, Nevada, well illustrates the quick advent of winter. Whereas the reading of 81° on the 17th constituted a new late season mark for heat, the reading of 8° on the morning of the 21st set a new figure for early season coldness. Again on the 22nd the mercury rebounded at Ely from a frigid 13° at sunrise to an afternoon maximum of 75°—such is the variety of life on the Plateau!

Despite the change of air mass inland, the heat wave continued its grip on the coastal strip of southern California where every October day at the Los Angeles Airport was three or more degrees above normal. October 1957 had been the hottest previous 10th month at the Airport, but 1958 exceeded all marks with a plus 9.1° departure. Downtown L. A. exceeded the October normal by 7.4° and had readings above 100° on the 15th, 16th, and 17th—the top figure 104° on the 16th equaled the all-time maximum for any October day. At San Diego it was the same story: warmest October of record, new high daily readings on the 15–17th, and the 97.8° on the 17th the highest ever recorded in October.

Further north it was a warm, dry month but not a record-breaker as in the South. San Francisco Airport had its warmest October since the start of records in 1928 with a four degree departure from normal, but the downtown office had a departure of only 0.8 degree—to illustrate again the difficulty of attempting to compare data from an airport and a downtown location when the exposures differ radically.

WESTERN DROUGHT—By far the most serious meteo-economic development of the summer and early fall concerned the drought situation in the central Plateau, Rocky Mountains, and northwestern Great Plains. Dry month after dry month have succeeded each other in the area extending from Nevada northeastward across the Great Divide into Montana and the western Dakotas. In October this area extended southward as far as northern Texas with many stations in Nebraska, extreme western Iowa, Kansas, and Oklahoma reporting absolute drought in October with no measurable precipitation.

The Salt Lake City area of Utah was among the greatest sufferers. Don Cameron called your editor's attention to the following precipitation figures for 1958 and the previous driest year, 1902:

	May	June	July	Aug.	Sept.	Oct.	Total
1958	.30	.04	.05	.23	.25	T	0.87
1902	.33	.37	.56	.15	.05	.52	1.98
Normal	1.56	.91	.61	.97	.74	1.34	6.13

Glasgow in eastern Montana experienced the 14th successive month with subnormal precipitation with only 0.13″ in October; during the 14 months rainfall has amounted to only 43% of normal. Dust storms became a menace in the area—a particularly severe occurrence with winds up to 85 mph reduced visibility to zero at Wolf Point, Montana, during the general storm on 20 October.

Rapid City in western South Dakota had the driest August–September–October in its 71-year record with only 0.51″ in that 92-day period. Sioux City in northwestern Iowa measured only a trace, marking only the second month in 69 years of record that no measurable precipitation fell.

Further south in Kansas and Oklahoma, where spring and early summer rains had been plentiful and well-distributed, complaints were raised in October of increasing dryness. Some places in Oklahoma at the end of October had no rain for seven weeks, and no soaking downpours in three months.

September (*Continued from page 213*)

the entire continent to southern California, the front separating a very strong flow of southwesterlies covering four-fifths of the country from a northerly polar flow in the area from Montana westward to the Pacific. The front moved eastward and southeastward at a slow pace on the 24–25–26th just as the circulation of Hurricane Helene appeared in the southeastern corner of the map.

HELENE—A report of a tropical storm on 23 September about 300 miles northeast of Hispaniola comprised the first notice of Helene, the most closely studied hurricane ever to approach the American shore. Full hurricane intensity was reached on the 24th, and for the next two days the disturbance followed a somewhat erratic course west-northwestward toward the Carolina coast. Residents of coastal Georgia and the Carolinas received warnings to expect gales and high tides early on the 26th, and by 1100 that morning, with the track of the disturbance unchanged, full hurricane warnings were raised from Savannah, Georgia, to Cape Fear, North Carolina.

Helene continued to intensify as it approached the coast, and by 1700 of the 26th the highest winds near the center were estimated at 125 mph. During the night it began to turn gradually toward the north. The center passed about 85 miles east of Charleston, South Carolina, at 0530 on the 27th, bringing gusts up to 63 mph at the airport and dropping the barometer downtown to 29.43″ (997 mb). It now became apparent that the Myrtle Beach area, a favorite recent target for hurricanes, and the Cape Fear country of North Carolina, were directly in the path. Evacuation of the islands and low coastal points proceded in full swing.

Helene appeared to have reached maximum intensity early on the morning of the 27th when at

the farthest west point of its now parabolic course—reconnaissance planes reported a surface pressure of 27.55″ (933 mb). Full hurricane winds raked the area of islands, sand dunes, swamps, and bays which make up coastal North Carolina. The largest city in the area is Wilmington which experienced gale force winds for over 27 hours, from 1823 on the 26th to 2200 on the 27th. The peak gust at the airport of 135 mph occurred at 1241 on the 27th, and the fastest mile of 88 mph came in from the north when the center was only 40 miles to the south-southeast. An excessive rainfall of 8.24″ fell in less than 24 hours.

Helene's center continued to flirt with the coastline on the afternoon and evening of the 27th, making a sharp recurve in consonance with the northeastward trend of the shoreline. The center passed very close to Cape Lookout, where gusts of 144 mph buffeted that exposed point, and then about 35 miles south of Cape Hatteras about 2100 in the evening. The highest gust at Hatteras was clocked at 106 mph and the barometer dropped to 28.73″ (973 mb). Rainfall totaled 4.46″ in a 12-hour period. Only superficial damage occurred in the Cape Hatteras area, and there were no injuries or loss of life. Nags Head, a bit further north, had a gust of 92 mph about 2200 when the center was well southeast. The high winds and heavy rainfall of Helene did not reach far inland—Raleigh measured only 0.07″ of rain and the highest mile of wind reached 33 mph. At Greensboro no rain fell.

Helene continued its full recurve on the night of the 27–28th and by dawn of the 28th stood 200 miles east of the North Carolina coast and was moving away on an east-northeast track at a speed of about 24 mph. Eventually the path shifted more to the north-northeast and the forward speed accelerated to about 40 mph. This took the center inland directly over the central part of Newfoundland on the morning of the 29th to give that island a rather severe lashing.

PACIFIC HEAT WAVE—The prolonged period of much above normal temperatures along the immediate coastline of California, already the greatest anomoly of the weather for 1958, continued into September. At the downtown office of the San Francisco weather bureau September averaged 5.2 degrees above normal to make it the warmest month of any year since 1871. Under the influence of almost unvarying westerly winds, the mercury topped the 80° mark on 12 days and reached a maximum of 92° on the 26th—still well below the all-time maximum of 97° set in September 1939. At the airport the departure from normal proved even greater —7.5 degrees for the warmest September in its short-period record commenced in 1928.

The heat area extended southward along the coast to Mexico. Downtown Los Angeles experienced its third warmest September since the commencement of records in 1874: there were 14 days with the mercury 90° or above. At the airport the previous September average was exceeded by an amazing 2.1 degrees! San Diego's temperatures totaled up to the second warmest September, missing the mark by only 0.1 of a degree. Since January 1st readings at San Diego have averaged 2.7 degrees above the normal.

In the interior there were many hot days. Sacramento with a total of 63 days this summer with 90° or more set a new record for that sunny location. Further north at Red Bluff minimum temperatures ran unusually high as a dry north wind prevailed all month; the highest reading for all 1958 did not come there until September 6th. The interior heat wave also broke through the northern coastal mountains of California on the 6th to give Eureka, usually shrouded in fog at this season, a maximum of 85° which equals the all-time maximum for that place.

There was some relaxation of the grip of the summer heat wave in coastal Oregon and Washington where every month since May had been excessively hot. Seattle and Portland in September were only slightly above normal, while the interior sections of the Northwest dropped below normal.

The reasons behind the remarkable warming of coastal California locations has recently been examined by Emmanuel M. Ballenzweig in the September *Monthly Weather Review*. He concludes that the warming is real and has not been caused by manipulation of the normals or by changes in instrument sites—these have remained the same since the distinct warming trend first came to notice in May 1956. But a survey of temperatures of coastal waters shows everywhere a distinct warming-up of ocean and bays during the past two and a half years, so a circulation pattern which favored westerly flow would tend to raise averages inland much above previous levels.

Nuclei Experiments

(*Continued from page 208*)

ing nuclei samples collected from condensation trials and "pure" cold chamber clouds, it is possible to gain insight into the role of the fuel in generating condensation nuclei. Such studies are currently under way.

It is anticipated that this apparatus will lend itself to investigations of crystal rehydration rates and droplet evaporation times as a function of drop size and relative humidity. Additional experiments await only the ingenuity of the interested investigator.

ACKNOWLEDGMENTS

The authors wish to thank Dr. James W. Ford for his valuable criticisms during the investigation and preparation of the paper. This work was supported by the Office of Naval Research under Contract Nonr-1854-(00), funds being provided by the Bureau of Aeronautics.

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"Grindstone" Clouds

(*Continued from page 203*)

one-third were actually identifiable as standing clouds, beyond any reasonable doubt. About half of the remainder were not surely identifiable as anything, largely due to photographic defects and limitations. The dregs of the collection consisted of everything from film defects to outright frauds.

On the basis of these summarized observations, it appears that an appreciable portion of the "flying saucer" reports from the western United States are not only honest reports of actual sightings of objects in the sky, but are reports of a specific cloud type—the "standing," lenticular," or "grindstone" cloud. This is in full agreement with Reed's analysis of the Arnold reports; and with the writer's own observations during similar reports in the Colorado foothills area.

For those reports which deal with little green men, who have journeyed hither in a flying saucer from the planet Bellerophon, which pursues a lemniscate orbit about the twin suns of Zeta Ginsbergii CXLII, the writer, who is untrained in psychiatry, has no explanation.

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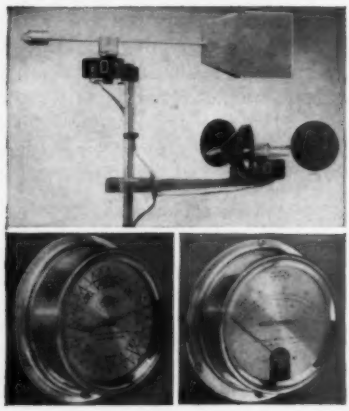

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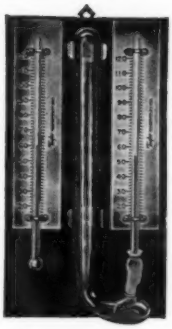

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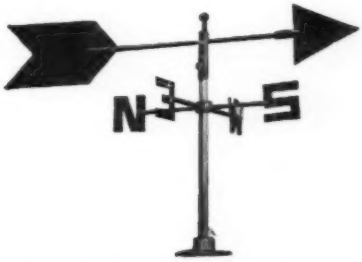

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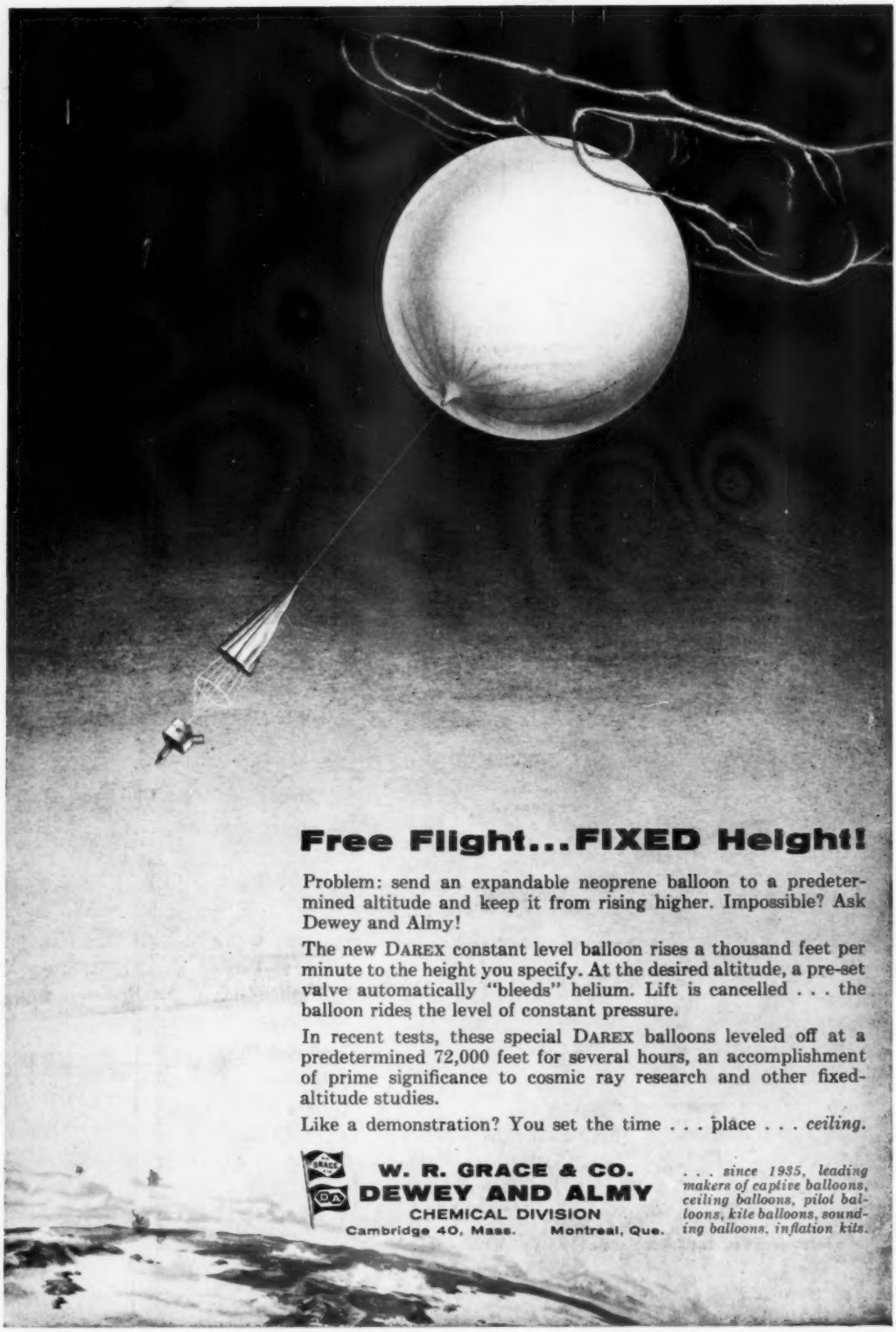

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